

METHOD AND APPARATUS FOR TRANSVERSE  
DISTRIBUTION OF A FLOWING MEDIUM

The present invention relates to a method and an apparatus  
5 for achieving even transverse distribution and propagation  
of a flowing medium.

For instance in the cellulose and paper industry it is  
necessary to be able to form webs of fibre suspensions in  
10 an even and wide distributed flow in the transverse and  
longitudinal direction on a base such as a roll, drum or  
the similar. An uneven formation may give a impaired pulp  
quality, for example due to fibre damages at subsequent  
press nips in thicker formed sections, canalisation of the  
15 washing liquid and poor efficiency at displacement  
washing.

Distribution of the flow of mediums is controlled  
substantially by friction losses (i.e. pressure drop) when  
20 the medium flows through a distributor. In order to ensure  
an even distribution, propagation and discharge of the  
medium in the transverse direction along a long and narrow  
gap, e.g. at a rectangular shaped distribution section,  
which is often desired, any of the two principles  
25 mentioned below can be applied:

- 1) Design the distributor such that the pressure drop  
along each streamline, for an evenly distributed outlet  
flow, from inlet to outlet, become essentially the same.
- 2) Provide a large pressure drop at the outlet of the  
30 distributor such that the differences in friction losses  
along different streamlines become negligible compared to  
the outlet friction losses.

One problem by applying the first principle (1) above is that the variation in velocity along individual streamlines of the medium flow is hard to predict. This fact in combination with the limited knowledge about the boundary layer behaviour of e.g. suspensions of wood fibres, makes it difficult to predict the pressure drop along the streamlines. One problem is clogging of the distributor when the fibres tends to slow down or adhere to the inner faces of the distributor which influences the runnability. Known distributors have also shown to be sensitive for variations in the flow velocity.

The present invention aims to provide a method and an apparatus according to the first principle where an improved propagation and distribution of a flowing medium is accomplished and where the above mentioned problems are minimised.

This object is achieved by a method for obtaining even transverse distribution and propagation of a flowing medium according to the present invention, where: the medium is supplied through a conduit and is deflected during propagation in at least one distribution gap defined by a friction surface; the medium is deflected during diverging propagation along the distribution gap; the medium is conveyed from the distribution gap via a passage to an outlet gap having a larger column depth than the distribution gap; the medium is conveyed over an edge, that constitutes a passage to the outlet gap, extending substantially transverse the direction of the flow; and the edge is shaped such that the friction surface obtain a propagation along the flowing path of the diverging medium in the distribution gap that provides a substantially even and parallel flow of the medium along the outlet gap.

In that respect, it is accomplished that friction losses, in accordance with the present invention, for an evenly distributed outlet flow, becomes essentially similar for all streamlines. The shape of the edge is intended to vary the quantity of frictional surface along different streamlines in the distribution gap, in order by that way provide an evenly distributed flow out of the outlet gap. Owing to the increase of the cross-section of the outlet gap at passage of the edge that extends substantial in the transverse direction, the pressure drop per unit of length along a streamline decreases, which causes the shaping of the outlet gap to become of reduced significance, in relation to other parts of the apparatus.

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By "medium" in this description is meant liquids, gases, foam, fibre suspensions or other mixture of substances.

After passage via the gaps, the medium passes an outlet opening. Preferably the outlet opening is preceded by several distribution gaps having different column depths for the purpose to control frictional losses in different parts of the machine.

25 An outlet gap may suitably have a column depth at the outlet opening that is in the size of 1.2-4 times the column depth of the preceding gap.

By "friction surface" in this description is meant those surfaces with which the flowing medium is in contact. It is the quantity of friction surface in the distribution gap, alternatively the distribution gaps, and not the outlet gap, that controls the profile of the flow. The

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shape of the edge may compensate for frictional losses in the outlet gap.

The present invention also relates to a distributor for  
5 even transverse distribution and propagation of a flowing medium. The distributor comprises a distribution housing with a conduit for supply of the medium and deflection during propagation in at least one distribution gap arranged in the distributor defined by a friction surface.  
10 The distribution housing comprises an outlet opening via which the medium is passing after passage through the distributor. The distribution gap is shaped with a diverging propagation. The distribution housing comprises a passage between the distribution gap and an outlet gap  
15 which is arranged with a larger column depth than the distribution gap. The passage comprises an edge, extending substantially transverse the direction of the flow, that constitutes a passage to the outlet gap; The edge is shaped such that the friction surface obtain a propagation  
20 along the flowing path of the diverging medium in the distribution gap that provides a substantially even and parallel flow of the medium along the outlet gap.

Additional features according to embodiments of the method  
25 and the apparatus according to the present invention is evident from the claims.

The present invention will now be described more in detail by examples of application, by reference to the  
30 accompanying drawings, without limiting the interpretation of the invention thereto, where

fig. 1A schematically in a perspective view shows a distributor according to an embodiment of the invention,

fig. 1B shows a cross-section A-A of the distributor in fig. 1A,

fig. 2A-D shows schematically in a view straight from above different embodiments of an edge of the distributor according to the invention, and the effect on the flow distribution out of the distributor,

fig. 3 schematically shows in a view straight from above another embodiment of a distributor according to the invention,

fig. 4A shows schematically in a perspective view yet an embodiment of a distributor according to the invention,

fig. 4B shows a cross-section A-A of the distributor in fig. 4A, and

fig. 5 shows schematically in a view straight from above yet an embodiment of a distributor according to the invention.

In figs. 1A and 1B are shown a distributor according to an embodiment of the present invention for even transverse distribution and propagation of a flowing medium. The distributor comprises a distribution housing 2 with a conduit 4 for supply of the medium and a wide outlet opening 6, the distribution housing is shaped with a distribution chamber 8 and an outlet chamber 10, which chambers are formed by limiting surfaces 12, whose inner faces are denoted friction surfaces. The supply conduit 4 in fig.1 is arranged at an angle to the distribution chamber 8, but may also be arranged in parallel to the direction of the flow S. The distribution chamber 8 has a distribution gap 14 that extends from the connection of the conduit in a diverging, conical propagation to a passage 16 having an edge 18, extending substantially transverse the direction of the flow, with a radius of

curvature R, which edge 18 e.g. has the shape of an arc, at which passage 16 the outlet chamber 10 is connected. The distribution gap 14 of the distribution chamber communicates via the passage 16 with an outlet gap 20 of the outlet chamber, which outlet chamber 20 is arranged with a larger column depth than the distribution gap 14 of the distribution housing 2, which outlet gap 20 extends from the passage 16 to the rectangular outlet opening 6. Both gaps 14, 20 have a substantially rectangular cross-section. The pressure drop along each streamline, from the supply via said conduit 4 to a discharge of the output flow of the medium via the outlet opening 6, for an even distributed outlet flow, is essentially the same, providing a substantially even and parallel outlet flow.

Since the distance along each streamline is not equal in the outlet chamber 10, the pressure drop in this shall be relatively small in comparison to the pressure drop in other parts of the apparatus.

The supply conduit 4 can be arranged in the vicinity of the intersecting line C for the diverging limiting surfaces. Preferably the distribution chamber 8, from the inlet forward to the edge extending essentially in the transverse direction, is provided with two diverging limiting surfaces and which preferably are interconnected by an edge 18 shaped as a circular arc.

According to an embodiment of the present invention, the passage between the distribution channel 8 and the outlet chamber 10 can be provided with sections of a plurality of distribution gaps, having different column depths, which is described more closely below with reference to fig. 5. Thus, the number of gaps with different column depth can

be more than two, suitably three or four, and the passage between two or a plurality of gaps may be provided by an edge shaped in a similar way as the edge 18 described herein. The distribution gaps may have increasing column  
5 depth along the direction of the flow. However, according to a preferred embodiment, the distributor according to the present invention comprises alternating increasing and decreasing column depths of the distribution gaps.

10 The purpose of arranging a plurality of gaps is to be able to control frictional losses in different parts of the machine. The gaps may have a column depth in the range of 8 to 60 mm.

15 An outlet gap at the outlet opening 6 can have a column depth ( $h_2$ ) that is in the size of 1.2-4 times the column depth ( $h_1$ ) of the preceding gap, suitably 1.5-4 times the column depth ( $h_1$ ) of the preceding gap.

20 The same reference numerals are used in the drawings to the extent that details in the different embodiments are in correspondence.

Fig. 2A-D shows variations of the shape of the edge 18 and  
25 where it is illustrated how the flow picture is altered when changing curvature of an arc-formed edge.

According to an embodiment, the edge 18 may have a substantially circular arc-formed extension with a radius  
30 of curvature  $R$ , which radius may have different curvature for different embodiments of distributors, such as for example is shown in fig. 2A-C. The supply conduit 4 can be arranged in a centre on a chord of the circular arc. Preferably the distributor chamber 8, from the inlet

forward to the circular arc of the apparatus, is substantially cone-shaped. This section may form a sector of a circle. Fig. 2C shows an embodiment of the circular arc where all radius  $R$  of the sector of the circle converge in one central point  $C$  (see also fig. 1A). In this way it is also ensured that the path each streamline follows from the inlet forward to the circular arc is equally long. Then the supply conduit 4 is placed in the central point  $C$ . The radius of curvature  $R$  of the circular arc may be larger than what is shown in fig. 2C, such as is evident from fig. 2A and 2B. On basis from that a shaping according to fig. 2B is assumed to produce an even distributed flow  $V$  along the whole outlet opening 6, there will be a change to a shallower circular arc, i.e. having a larger radius of curvature  $R_1$  than the shaping of the edge with the radius of curvature  $R_2$  in fig. 2B, resulting in a larger flow  $V_1$  in the middle of the outlet opening and a smaller flow  $V_2$  against the side edges 12' of the outlet opening in comparison to fig. 2B. If instead, in comparison with fig. 2B, a deeper circular arc is provided, i.e. having a smaller radius of curvature  $R$  than the shaping of the edge having the radius of curvature  $R_2$  in fig. 2B, this results in a lower flow  $V_2$  in the middle of the outlet opening and a larger flow  $V_1$  at the side edges 12' of the outlet opening in comparison to the shaping according to fig. 2B.

In fig. 2D is shown an embodiment of another shape of the edge 18, here made of two essentially straight edge sections 22, 24 that are met in a point near the middle of the outlet opening 6. The edge sections 22, 24 form an angle  $\alpha$  between them. The flow picture for the shown embodiment of fig. 2D is similar to fig. 2C, i.e. the flow  $V_1$  is largest at the side edges 12' of the outlet opening



and lower  $V_2$  in the middle of the outlet opening in comparison to the shaping according to fig. 2B. The edge may also be provided with other angles between the straight sections of the edges 22, 24, depending on which flow picture that is desired along the outlet opening. The edge 18 may also be provided with more than two edge sections (not shown).

In fig. 3 is shown an embodiment according to the present invention. By an essentially circular arc-formed edge 18 is meant that sections of the edge 18 may have a differing shaping, but that the passage between the distribution gap 14 and the outlet gap 20 mainly follows the shape of a circular arc. For instance, the circular arc may against the respective side edges 12' of the apparatus terminate with straight sections 22, which sections substantially extends parallel with the side edges 12' of the outlet chamber. The circular arc may thus be shortened against the side edges 12' in order to compensate for increasing frictional losses at the edges 12'.

According to the invention, the flow is moving through a channel extending substantially in the plane. For that reason, redirection of the flow is minimised, whereby problems with clogging can be minimised. According to yet one embodiment according to the present invention, as evident from fig. 4A-B, the apparatus may nevertheless comprise at least one redirection 24, such as a curved section or the similar. The pressure drop in consequence of the redirection is negligible. This design can be preferred for technical assembly reasons.

In fig. 5 is shown a preferred embodiment according to the present invention, where the distributor comprises a first

distribution gap 14', a second distribution gap 14'', a third distribution gap 14''' and an outlet gap 20. The first distribution gap 14' is arranged from the inlet forward to a first circular arc-shaped edge 18' that  
5 interconnects two diverging limiting surfaces that constitutes a first distribution chamber 8'. The second distribution gap 14'' is arranged from the first circular arc-shaped edge 18' forward to a second circular arc-shaped edge 18'' that interconnects two diverging limiting  
10 surfaces that constitutes a second distribution chamber 8''. The third distribution gap 14''' is arranged from the second circular arc-shaped edge 18'' forward to an edge 18''' extending essentially linear in the transverse direction, that interconnects two substantially diverging  
15 limiting surfaces that constitutes a third distribution chamber 8'''. The edge extending in the transverse direction constitutes the passage to the outlet gap 20. Sections of the side edges 12'' of the gaps 14', 14'', 14''' and 20 are angled in the broken points P at the  
20 second distribution gap 14'' and at the third distribution gap 14'''. The second distribution gap 14'' preferably has a lower column depth than the first distribution gap 14'. The third distribution gap 14''' preferably has an equal column depth as the first distribution gap 14'. The outlet  
25 gap 20 has preferably a larger column depth than the third distribution gap 14'''.

With reference now to the figs. 1-5, a fibre suspension having a concentration of e.g. up to 12% may thus be  
30 supplied to the distribution housing 2 via the supply conduit 4. The fibre suspension that enters the distribution chamber 8, 8' hits the inner limiting surfaces 12 of the housing and is thereby deflected. The suspension is spread from the inlet by decreasing speed

outwardly in the distribution gap 14, 14' in the diverging distribution chamber 8, 8' to the passage 16 where it once more is deflected when it passes the edge 18, 18' of a preferred circular arc-shape and passes into the outlet gap 20 having a larger column depth, alternatively passes into yet one distribution gap 14'' having a preferred lower column depth and thereafter a distribution gap having a higher column depth than the preceding gap before the outlet gap 20 as described with reference to fig. 5. After the suspension has been conveyed into the outlet chamber 10, the suspension is forced against the outlet opening 6 to flow in an even substantial parallel flow with a constant velocity.